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TRIBOLOGICAL INVESTIGATION OF COCONUT COIR/BANANA FIBERS/GLASS FIBER REINFORCED HYBRID POLYMER MATRIX COMPOSITES

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Abstract:

Coconut coir (C) banana fibers (B) and glass fibers (G) were chopped to a very small length and reinforced with unsaturated polyester (USP) by using compression molding. In this method different weight percentage of C-USP (coir reinforced unsaturated polyester), B-USP (banana fiber reinforced unsaturated polyester) and C-B-G USP (coir, banana and glass reinforced unsaturated polyester) hybrid composites were prepared. Tribological behaviors were tested on two body abrasive tester by varying the abrading distance 80 m to 160 m and applying the normal load of 5N and 10N respectively. This work revealed that abrasion resistance of the composites depends upon the weight percentage of C or B or G and abrading distance. Also the wear rate of the composites directly depends on the abrading distance and the load. For 80 m of abrading distance and 5 N of load, the wear loss was less and for 160 m of abrading distance and 10 N of load wear loss was more. But on comparison with the C-USP and B-USP, for higher abrading distance at 160 m and at 10 N of load, C-B-G-USP composites gave excellent abrasion resistance. This study shows different trends for various composites considered in this study and effect of reinforcements on abrasive wear.

Keywords-Hand layup, composites, abrasive wear, unsaturated polyester (USP), tribology.

Introduction:

Composites are made up of two or more materials at macro level so that they form a new structure and these structures are having better physical and chemical properties than the individuals that used. Composites basically have reinforcements and matrix phase, these reinforcements gives strength to the composites and matrix gives good bonding between the reinforcements. In this work finely chopped coconut coir, banana fibers and glass fibers were used as reinforcements. These fibers are chopped to a micro level and mixed in various proportions. In the present scenario

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world needs more and more renewable, biodegradable, less cost, non toxic materials and good properties of mechanical and greater abrasion resistance. For these good replaceable are natural fiber reinforced composites.[1-6] Fiber matrix interface plays important role for mechanical properties of the composite materials.[7-8] Coir is one of the best reinforcement among the several natural fibers because of its strength and durability. Also, it can absorb good amount of water in it and they posses very good abrasion resistance. Also coir proved its effectiveness in thermo-set and thermo plastic matrices [9-16].

Experimental Details

Materials used:

1. Matrix material: Unsaturated polyester : General purpose with the grade SBA 2303
2. Catalyst : M E K P (Methyl ethyl ketone peroxide)
3. Accelerator : cobalt- naphthenate
4. Silane treatment : Trichlorovinyl silane
5. Chopped Coconut coir
6. Chopped Banana fibers
7. Chopped Glass fibers

Silane treatment of fibers: Initially coconut coir and banana fibers were washed in cold water and dried in open sun light. Than the dried fibers were kept in 1 Normality alkali solution for an hour and then washed in distill water and dried in open sun light. 0.3 % Trichlorovinyl silane in 1 liter of acidified water was prepared and fibers were immersed in it for an hour and later fibers were taken out and kept open in the atmospheric condition for one day. Later the fibers were chopped for very small size as required for the composites.

Fabrication of composites: Different C-USP/B-USP and C-B-G-USP percentage composites were prepared by compression molding process. The Close mold was used in compression molding process. In this process, the mould made up of normal ply-wood is prepared to fit the structure to be produced. Releasing agent was applied initially on the mould after cleaning it. So that the mould prevents itself from the sticking with matrix or any fibers during the manufacturing. Then previously calculated combination of fibers for reinforcement and resins are poured into the mould. After pouring of mixture, it is compacted using a roller so that wetting of the resin with the reinforcement takes place. The semi-gelled composite is left in the mould for curing, during which curing polymerization of the resin takes place and it becomes hard by cross-linking of the chains. After approximately 1 hour the mold is released and a half cured composite is removed out from the mold. This half cured composite takes approximately 24 hours for full curing to take place. Different combinations of composites were prepared as shown in the table1.1

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Table 1.1: Composites table

Composites	Code	USP weight %	Coir weight %	Banana weight %	Glass weight %
Coconut coir	C-USP 20-80	0.8	0.2	-	-
	C-USP 30-70	0.7	0.3	-	-
Banana fiber	B-USP 20-80	0.8	-	0.2	-
	B-USP 30-70	0.7	-	0.3	-
Coconut-Banana-Glass	C-B-G-USP 20-80	0.8	0.07	0.07	0.06
	C-B-G-USP 30-70	0.7	0.1	0.1	0.1

Experiment and results:

Tribological Study: Pin on disc test

In order to study the wear resistance properties of the prepared composite materials pin on disc test rig is used as shown in the figure 1.1. Mainly three parameters were considered for the wear resistance test. Such as, abrading distance, load and speed of the disc rotation. Table 1.2 will gives the detailed specification of the two body wear test.

Table: 1.2: Parameters for tribological test.

Parameters	Value/details
Abrading Distance	80 m and 160 m
Load	5 N and 10 N

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Speed	200 rpm
Track Diameter	80 mm

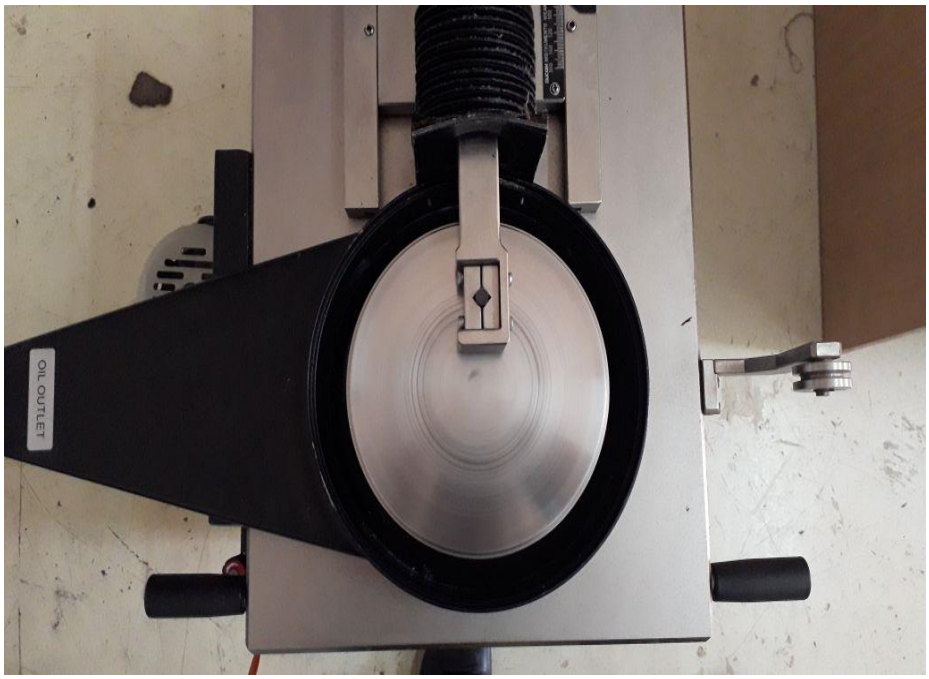

Figure 1.1: Pin on disc test rig machine

In this test Sic 120 grit size paper was pasted on the disc and by keeping the speed constant at 200rpm; test was conducted for all the composites. The detailed results for this test are given in the table 1.3 below.

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Table 1.3: wear rate and frictional force results for 80 meters and 160 meters abrading distance

Composites	Wear rate		Frictional force	
	80 Meters	160 meters	80 Meters	160 meters
C-USP 20-80	1630	1930	6.6	6.7
C-USP 30-70	1410	1837	6.2	7.3
B-USP 20-80	1655	2054	6.2	6.4
B-USP 30-70	1425	1900	6.8	6.5
C-B-G-USP 20-80	820	1225	5.3	5.2
C-B-G-USP 30-70	710	1020	5.7	5.8

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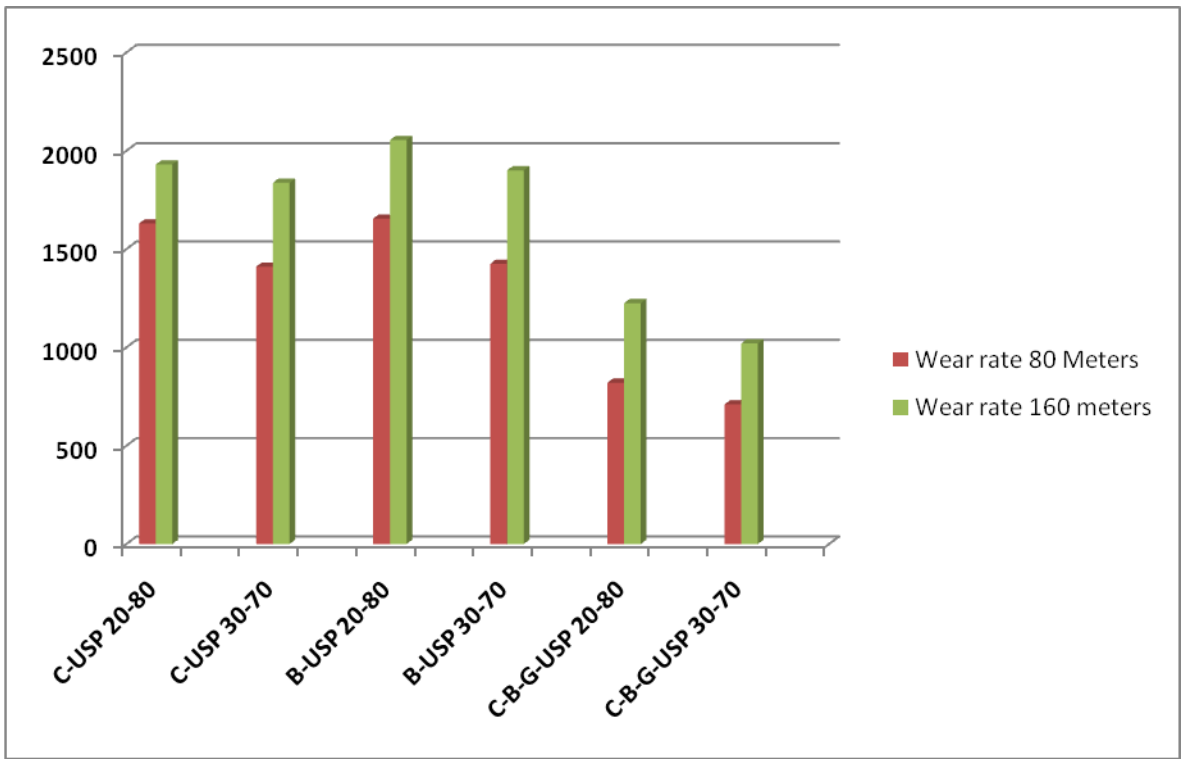

Figure 1.2: Graph Different percentage of composites VS wear rate in microns

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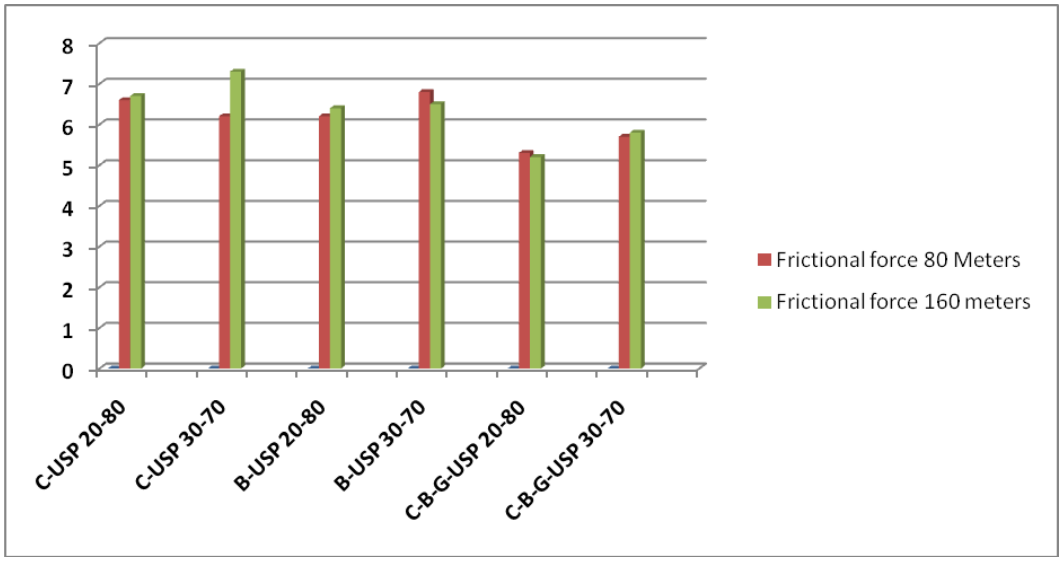

Figure 1.3: Graph Different percentage of composites VS frictional force

From the graph (figure 1.2 and 1.3) the following conclusions can be made:

1. As the abrading distance increases wear loss is also increasing. As the percentage of fiber reinforcements increases the wear resistance of the composite is also increasing.
2. For the coir and banana alone reinforcements composites the wear loss is more as compare to the hybrid composites combination. From the table 1.3 it is observed that wear rate for C-USP composites and B- USP composites wear rate is around 1600 microns (20-80 combination) whereas for hybrid combination wear rate is drastically falling to 820 microns.
3. As the abrading distance increases the wear rate increases. In the figure it can be easily identified that C-B-G-USP 20-80 composites are having wear rate of 820 microns for 80 meters of abrading distance whereas 1225 microns for 160 meters of distance.
4. Also it has been observed that the hybrid composites are having comparatively lesser frictional force values. From the table 1.3 it can be observed that C-B-G-USP 20-80

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composites are having frictional force of 5.3 whereas C-USP are having 6.6 frictional force value for 80 meters of abrading distance.

5. Frictional force will not change much even though percentage of reinforcements is varying in a great percentage. Figure 1.4 supports this statement.
6. Banana fibers and coir fibers showed better wear resistant as we can observe that increase in banana and coir fiber loading decreased the wear rate.

REFERENCES:

1. G. Bogoeva Gaceva, A. Dekanski, V. Panic, and D. Poleti, XLIV. Meet. Serbain Chem. Soci., Beigrade, 89 (2006).

2. K. Joseph, S. Thomas, and C. Pavithran, Polymer, 37, 5139 (1996).

3. N.F. Levy, J.C. Balthazar, and C.T. Pereira, 3rd Int. Symp.Nat. Poly. Comp.-ISNAPOL, Sao Pedro, 376 (2000).

4. A.R. Martin, S. Manolache, F. Denes, and L.H.C. Mattoso, J Appl. Poly. Sci., 167, 739 (2000).

5. C. Navin and J. Deepak, Composites Part-A, 36, 594 (2005).

6. Medeiros, Agnelli, Kuruvilla Joseph, Laura and Mattoso, Poly. Comp., 26, 1 (2005).

7. J. Rout, M. Misra, S.S. Tripathy, S.K. Nayak, and A.K. Mohanty. Comp. Sci. Tech., 61, 1303 (2001).

8. H.G. Kim and D.J. Lee, Int. J. Poly. Mat., 28, 61 (2005).

9. P.R. Hornsby, E. Hinrichsen, and K. Tarvedi, J. Mater. Sci., 32, 1009 (1997).

10. J. Tong, R.D. Arnell, and L.Q. Ren, Wear, 221, 37 (1998).

11. L.A. Pothana, Z. Oommenb, and S. Thomas, Comp. Sci. Tech, 63, 283 (2003).

12. P.J. Roe and M.P. Ansel, J. Mater. Sci., 20, 4015 (1985).

13. M. Jacoba, S. Thomasa, and K.T. Varugheseb, Comp. Sci. Tech., 64, 955 (2004).

14. K. Ghavami, R.D. Toledo Filho, and N.P. Barbosa, Cem. Con. Comp, 21, 39 (1999).

15. N.S.M. El-Tayeb, Wear, 265, 223 (2008). 28. U.K. Dwivedi, A. Ghosh, and N. Chand, Bio-Resources, 2,693 (2007).

16. I.M. Hutchings. Tribology: Friction and Wear of Engineering Materials, CRC Press, London (1992).